OCR Computer Science A Level

1.1.3 Input, Output and Storage
Advanced Notes

Specification:

1.1.3 a)

- How different input, output and storage devices can be applied to the solution of different problems.

1.1.3 b)

- The uses of magnetic, flash and optical storage devices.

1.1.3 c)

- RAM and ROM.

1.1.3 d)

- Virtual storage.

Input, Output and Storage Devices

An input device is one which can be used to put data and information into a computer. Likewise, an output device is one which can be used to send information from the computer.

Examples of input devices include:

Keyboard
Used to enter text into a computer

Webcam
A camera used by a computer to take photos and record videos

Magnetic stripe reader
Used to read data from magnetic stripes on cards like credit and debit cards

Barcode reader
Used in supermarket checkouts and access control systems to read information from printed labels and cards

Examples of output devices include:

Speakers
Used to output sound from a computer

Printers
Used to output information from a computer onto paper

Projector
Used to project video content from a computer onto a screen

A small number of devices can be categorised as both input and output devices. For example, a touch screen outputs information in a visual way like a monitor, while acting as a device for touch input.

Important things to consider when purchasing an input device include the speed and accuracy of input. Different devices will be able to transfer data at faster rates or to record information in greater detail. In addition, cost and relevance must be considered. Is this device the right one for the task?

The Use of Storage

There are a variety of different methods of storing information, each of which is suited to a particular type of information. Some devices are best for storing small quantities of information, while others are suited to large capacity storage.

Optical

Optical devices are read from and written to using lasers. Binary information is represented by portions of the disc which either reflect or scatter the incident laser light written in spiral tracks on the disc's surface.

A microscopic view of the surface of a CD. The portions which are recessed, called pits, scatter light whereas the flat portions, called lands, reflect light. Pits represent a 0 and lands represent a 1.
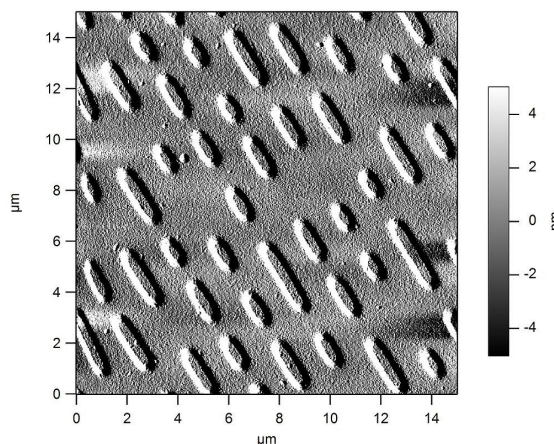
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CDs

CD stands for compact disc. They use optical technology to store small quantities of information. Most commonly used for audio files, CDs can also be used to store text and digital images. CDs are small, thin and light which makes them very portable.

Their disadvantages include being easily damaged by scratches, their limited storage capacity and relatively slow transfer speeds. Varieties of CD include CD-R which can only be written to once, CD-RW which can be written to more than once and CD-ROM which is written to during production and can then only be read from.

DVDs

DVD stands for digital versatile disc or digital video disc. Similar to CDs, DVDs are also optical devices which have a higher storage capacity than CDs, making them suited to storing digital videos which require more storage space than audio files or photos.

Blu-Ray

An advancement over DVDs, blu-ray discs have more than five times as much storage than traditional DVDs, making them useful for storing high-resolution films.

Magnetic

Devices which store information magnetically represent binary information using two magnetic states: polarised and unpolarised. If a portion of magnetic material is polarised, all magnetic poles align and can be read by a read/write head passing over the region. If an area is not polarised, magnetic poles are randomly scattered and produce a different reading on a read/write head. These two states can represent 1 and 0, allowing any information to be represented in binary form.

The most common type of magnetic storage is hard disk drives. However, magnetic tape (including cassette tapes) also stores information magnetically.

Hard Disk Drives

Sometimes abbreviated to HDD, hard disk drives typically have high capacities of between 500GB and 5TB. They work by rotating magnetic platters at high speeds under a read/write head on an actuating arm. The combination of the arm and rotating platter allows the read/write head to access any part of the platter. Most HDDs will have multiple platters stacked on top of each other to maximise storage capacity.

Disadvantages of HDDs include their somewhat slow data transfer speeds and their tendency to become damaged by movement. The combination of brittle platters and moving parts results in a delicate device.

Magnetic Tape

First used to record computer data in the 1950s, magnetic tape was a popular storage medium right through to the 1980s. Wound onto reels, long stretches of tape were passed through readers which would check the polarity of the tape and read off a binary value. Tape was a bulky way to store data, and although improvements were made by reducing the width of the tape and writing in diagonal lines as opposed to horizontal tracks, the technology was superseded by more modern technology like ROM cartridges.

Floppy Disks

A floppy disk comprises a thin magnetic disk (which would have originally been flexible, hence the name) enclosed in plastic to protect the disk from dust and dirt. They were incredibly portable, thanks to their thin size and low weight, so became popular for exchanging small amounts of data - in a similar way to how USB flash drives are used today. Floppy disks had a typical storage capacity of 1MB although some later versions boasted as much as 200MB.
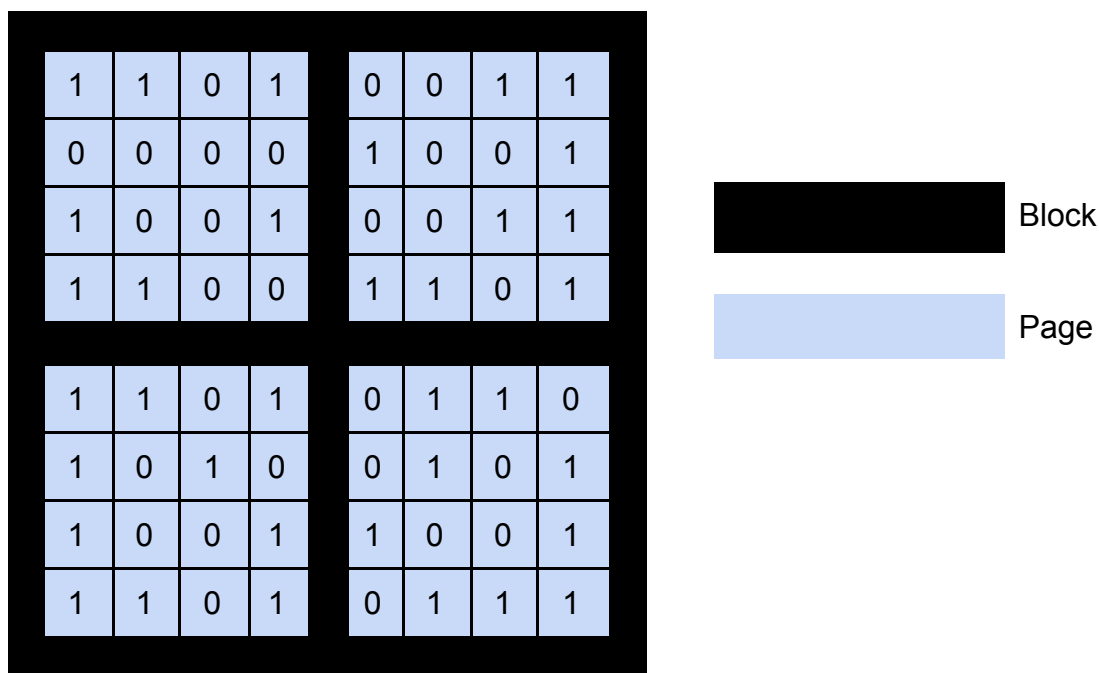
Flash

Flash storage is fast and compact. The technology makes use of silicon semiconductors forming the logic gates NAND and NOR to store electrical charge in one of two states: high or low. These two states represent the binary values True and False, which can be used to represent information.

Information is stored in blocks, which are combined to form pages.

1	1	0	1		0	0	1	1
0	0	0	0		1	0	0	1
1	0	0	1		0	0	1	1
1	1	0	0		1	1	0	1

1	1	0	1		0	1	1	0
1	0	1	0		0	1	0	1
1	0	0	1		1	0	0	1
1	1	0	1		0	1	1	1

Block

Page

The preferred logic gate used for storing small quantities of data, such as code to be executed, is NOR. For larger files, like photos and videos, NAND is the preferred technology.

Flash memory can be erased and reprogrammed electronically, and is non-volatile, meaning it stores its data even when power is lost. These features make SSDs a good replacement for HDDs as they have the same functionality but improved performance.

Although flash memory is similar to RAM, the two differ in that RAM is volatile (loses its content with loss of power) while flash memory retains its information.

As a general rule, flash memory is more expensive per gigabyte than other methods of data storage, like magnetic and optical.

Solid State Drives
Often referred to as SSDs, solid state drives are currently one of the most popular forms of data storage. They are extremely light and portable, while having no moving parts - this makes them much more resistant to damage from movement than hard disk drives, which are packed with moving parts. Furthermore, SSDs are renowned for their high data transfer rates. The primary disadvantage of SSDs is their cost, which continues to decrease as they become more common. Another disadvantage is their limited lifespan. Every time a page is written to, the voltage required to write to it increases. Over time, this required voltage will become too high for the page to be written to.

RAM and ROM

So far, we've seen secondary storage devices, used to store user data like images and videos. RAM and ROM are two types of primary storage, used by the computer's operating system to run the computer. They store information like code instructions to execute and files which are required by running programs.

RAM
Random access memory is a type of fast main memory used to store data and programs that the computer is currently using. This speeds up the computer's execution as RAM has higher access speeds than even flash memory. RAM is more expensive per gigabyte than secondary storage devices, so computers often have only 4 or 8 GB or RAM compared to 100s or 1000s of GB of secondary storage.

RAM is volatile, meaning that it loses its information when power is lost. For this reason, RAM isn't used for storing personal files but as temporary storage while the computer is running.

ROM
Read only memory, as the name suggests, cannot be modified. Once programmed, the state of the memory cells inside do not change. ROM is useful for storing fixed sequences of instructions like a computer's startup (bootstrap) routine. ROM is non-volatile, so it retains its data even when the computer is powered off.

Virtual Storage

Virtual storage is the name given to storing information remotely so that it can be accessed by any computer with access to the same system, for example over the Internet. Examples of virtual storage include cloud storage services like Google Drive and Microsoft OneDrive as well as networked storage used in offices and schools.

As internet speeds increase, virtual storage is becoming a more popular method of storage thanks to the convenience of files being available "in the cloud" on any device connected to the Internet.

Virtual storage is often an abstraction of multiple drives acting like one. Information stored in the cloud is actually stored on 100s of hard drives or SSDs formatted to act as a single piece of storage.

While virtual storage is convenient to access and share, its disadvantages include limitations of a user's network speed and high costs.